Chapter 2
Theoretical Conceptualization of ESS in Rural-Urban Synergies

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Abstract In this chapter, we will discuss Ecosystem Services (ESS) and how its conceptual framework has evolved during the ROBUST project to shed light on its usefulness in understanding and strengthening rural-urban synergies. Methodologically, this reflection builds on a combined review of relevant literature and cases explored within the project's Living Labs. The primary aim is to report on the process of advancing towards a theoretical conceptualization of ESS with respect to rural-urban synergies, as illustrated in the ESS multi-loop framework. This framework aims to display multiple levels of conceptualization of rural-urban synergies beyond the ROBUST project, emphasising the pivotal role of planning and governing ESS.

Keywords Ecosystem services · Rural-urban synergies · Concept of ecosystem services · Socio-ecological systems

2.1 Introduction

'Ecosystem services' (ESS) are the ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being: that is, the benefits that people derive from functioning ecosystems (Costanza et al., 2017). The concept was introduced to better communicate the value of nature and natural processes to policy and decision-makers and thereby protect high value ecosystems, avoiding biodiversity loss (Daily in Marris, 2009).

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In recent years, the concepts and approaches to explain, contextualise and describe ESS have multiplied in the literature, as outlined in Sect. 2.2, below. Ultimately, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) synthesised the complex interactions between the natural world and human society in their conceptual framework (Fig. 2.1), widening the definition of ecosystem services as nature's contributions to people by considering them "The benefits (and occasionally losses or detriments) that people obtain from ecosystems" (Diaz et al., 2015:13).

The main elements in this framework, fully addressed in the IPBES global assessment report (IPBES, 2019), include nature and anthropogenic assets, their relationships and governance, including regulated, material and non-material contributions to people, the direct and indirect drivers of change as external factors that affect this system of relationships, the institutional and governance systems, and good quality of life and human well-being as the ultimate goal.

This chapter builds upon these scientific and policy advances and sets the theoretical conceptualization of ESS with respect to its role in establishing links between rural and urban systems, and enhancing their synergies. It draws substantially on the research work jointly developed by practitioners and researchers in the EU-funded Horizon 2020 ROBUST project on enhancing rural-urban relations. The chapter

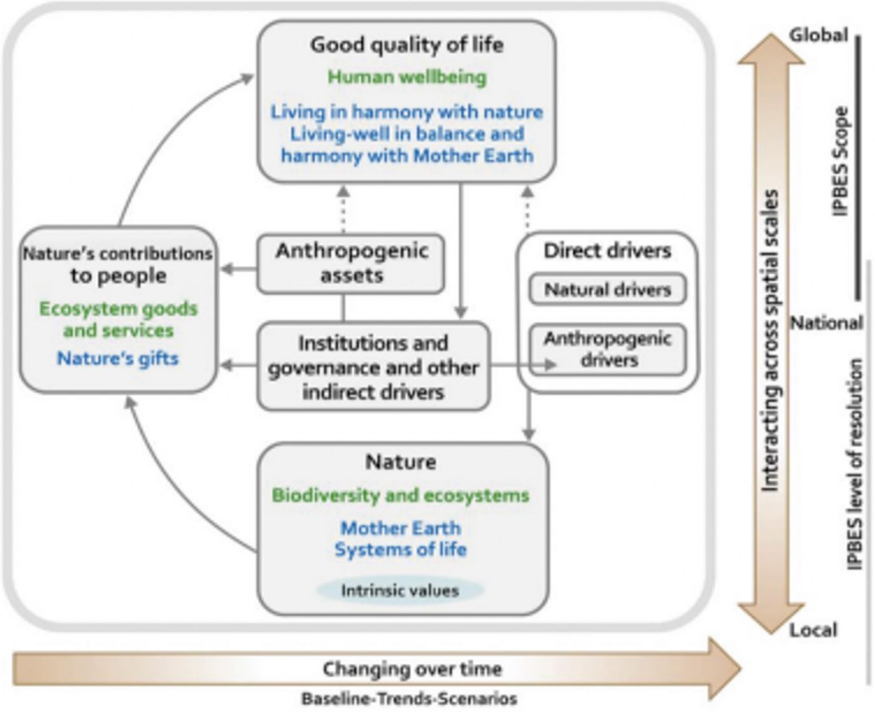

Fig. 2.1 Representing the IPBES conceptual framework (Díaz et al., 2015)

shares the evolving ESS concept within ROBUST, through (a) review of literature and of cases, (b) discussions within the Communities of Practice (CoP), and (c) the development of ROBUST's conceptual framework. Beyond setting the theoretical conceptualisation of ESS with respect to R-U synergies, leading to what has become the ESS multi-loop framework presented ahead, the chapter also shows how this process of conceptualisation has evolved over time and how and why the authors have arrived at this final framework.

The concept of ESS was adopted as a functional theme (a Community of Practice - CoP) in ROBUST because of its potential to enable rural-urban linkages and synergies, evident in the provisioning and regulating services but also in cultural and supporting or habitats services. It was a foundational research premise that ESS can establish key functional relationships in spatial and sectoral planning, contributing to a redefinition of rural-urban relations. The role of ESS in rural-urban synergies can thus be enhanced when associating ESS use and delivery to planning instruments and governance models at multiple scales.

The role of ESS in rural-urban relations is, however, still unexplored in the literature from the perspective of synergies, which are understood as mutually advantageous interactions producing a combined effect greater than the sum of their separate effects. Indeed, rural-urban relations, despite their mutual interdependence, have not been extensively explored from a synergetic point of view in general (van Leeuwen, 2015). ROBUST thus offers two departures from existing ESS perspectives. Firstly, an explicitly spatial perspective is taken which highlights rural and urban connections by examining five functional flows, of which ESS is one. Secondly, ROBUST's approach indicates the synergistic potential offered by ESS and identifies modes of governance that can enhance this potential, leading to stronger rural-urban links.

The most common approaches to the role of ESS in rural-urban relations have focused on flows—from rural to urban and vice versa—encompassing flows of goods and energy, and flows of people (Lewis et al., 2022). The understanding of flows from a territorial view point, *"as the reciprocal and repetitive flow of people, goods and financial and environmental services between specific rural, peri-urban and urban locations"*, has been used to express spatial and functional relations between urban and rural communities (Kroll et al., 2012). ESS related to food and tourism echo frequently as drivers of possible synergetic relations (e.g. Lacourt, 2015). Nevertheless, Chaps. 9 and 14 (cultural ESS) challenges this line of reasoning by highlighting the asymmetrical benefits, notably the downside to rural communities. This differentiated access to ESS by rural and urban people has been theorised by Cumming et al. (2014).

In the literature, there is an apparent common understanding that benefits exist from ESS-driven flows across urban and rural territories. Still to be explained is how these flows sustain relations that go beyond linkages (into the promotion of synergistic outcomes). Eventually, van Leeuwen's (2015) approach exploring the *"advantage of adjacencies"* might show a way to progress towards better understanding the synergic role of ESS in this context.

2.2 Updates on ESS in the Context of Socio-ecological Systems

The concept of ESS gained traction in the development of environmental research and policies, giving shape to a redesign of socio-ecological relations (Chaudhary et al., 2015). Emerging in the 1970s as *"environmental services"* (Wilson & Matthews, 1970), it was later renamed as ecosystem services in the 1980s by Ehrlich and Mooney (1983). Later, Costanza et al. (1997) set a ground-breaking advance by quantifying the value of ESS and natural capital. This seminal research enabled the competitive valuation of ESS within the assessment of externalities, helping to reinforce the tangibility of the benefits, and costs, brought to society by ESS in terms comparable to other shadow processes in cost-benefit analysis.

With the Millennium Ecosystem Assessment (MEA, 2005), the concept of ESS made its way into the policy agenda (Braat & de Groot, 2012). The MEA was the first assessment at a global level on the status of ESS worldwide, but also highlighted the effects of ecosystem changes on human well-being. The MEA also intended to set the scientific basis for the action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being.

In recent years, the literature on, and investigation of, ESS has multiplied. The definitions, classifications and applications of this concept evolved rapidly as researchers, policy makers and managers explored the benefits that ecosystems provide to people. The work developed within the international initiative The Economics of Ecosystems and Biodiversity (TEEB), the main goal of which was "to mainstream the values of biodiversity and ecosystem services into decision-making at all levels" (TEEB, 2010), has been remarkable.

In TEEB the earlier categorization of ESS advanced by the MEA was adopted, with ESS divided into four main categories: provisioning, regulating, cultural and supporting services (MEA, 2005; TEEB, 2010). All are underpinned by biodiversity and illustrate the flows of values which benefit society as a result of ecological functions.

- Provisioning ESS include all the nutritional, non-nutritional, material and energetic outputs from living systems as well as abiotic (non-living) outputs (such as provision of food, fibres and wood, fresh water).
- Regulating ESS include all the ways in which ecosystems can mediate or moderate the ambient environment and which affect human health (e.g., climate regulation, moderation of extreme events, erosion prevention or biological control).
- Cultural ESS are all the non-material and non-consumptive outputs of ecosystem (biotic and abiotic) that affect the physical and mental states of people (e.g., recreation, aesthetic pleasure, spiritual experiences).
- Supporting ESS are defined as the ecological processes and functions that are needed for the production of the previous *final* services (e.g., species habitats, pollination, maintenance of genetic diversity) (Baró et al., 2016).

Figure 2.2 illustrates a subsequent conceptualization of ESS with the cascade model defined by Haines-Young and Potschin (2010) to express the relationship between biodiversity, ecosystem services and human well-being.

The link between nature and the economy is illustrated in the cascade model, which divides socio-economic and environmental systems into two interdependent spheres. Biophysical structures and processes result in ecological functions and services which create societal benefit and economic value. Because social and economic actions place pressure on the biophysical structure of the environment, an important backflow from the socio-economic to the environmental sphere lies in the development of instruments and actions to restore it. Neither the earlier MEA/TEEB model or the cascade model make explicit spatial distinctions.

In the classification of ESS there are several interpretations of the meaning of biophysical structure, ecological functions, intermediate services and final services (Haines-Young & Potschin, 2010) (see Fig. 2.2). Because of challenges in interpreting the variety of classifications of ESS, Burkhard and Maes (2017) refer to the need to adopt a standard categorization methodology for the classification of the ESS. The Common International Classification for Ecosystem Services (CICES), initiated by the European Environment Agency in 2009, sets a landmark by creating a frame of reference for ecosystem services research (Maes et al., 2014). In the European Union, the work on Mapping and Assessment of Ecosystems and their Services (MAES) uses CICES as the framework for its work developing ESS indicators (Czúcz et al., 2018). The MAES initiative became a key tool to reach the commitment made under Action 5 (of Target 2) of the EU Biodiversity Strategy to 2020 (Maes et al., 2014). After several reviews, the latest version of the CICES (V5.1)

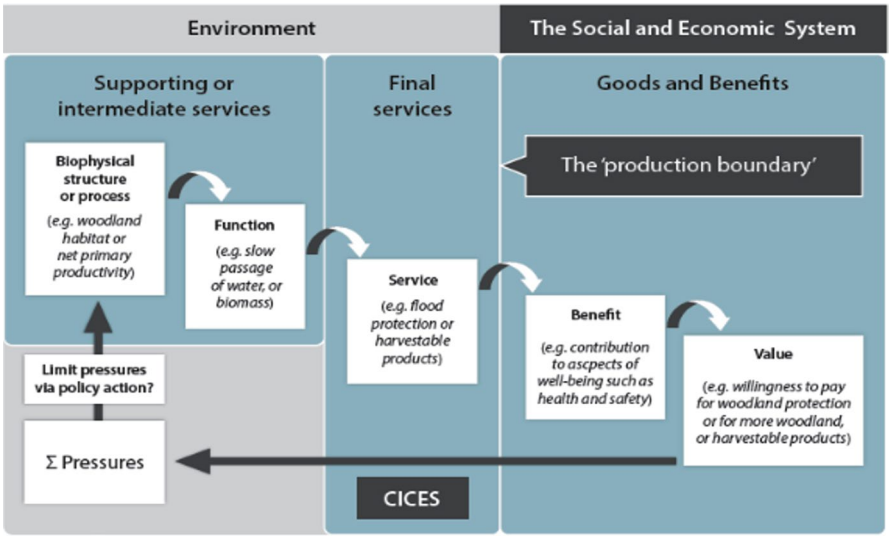

Fig. 2.2 Cascade model by Haines-Young and Potschin (2010)

was proposed in 2018 and aims to progress towards a standardisation of ESS classification.

The cascade model, represented in Fig. 2.2, provides the conceptual framework in which CICES is set. CICES classification describes ecosystem final services using a five-level hierarchy (section>division>group>class>class type), focusing on the final outputs of ecosystems that people can use in a beneficial way (Haines-Young & Potschin, 2018). It is also relevant to mention that CICES V5.1 separates biotic and abiotic factors, allowing users to select only those ESS that depend on living systems (i.e. biodiversity in its broadest sense) or to include the non-living parts of ecosystems that can also contribute to human well-being.

Research published by Constanza et al. (2017) is an important landmark that indicates work that still must be done in ESS studies. It highlights the main weaknesses of the mainstream approach to valuation, growth and development and provides recommendations for the future. Among its conclusions is the need to integrate ESS and natural capital into the mainstream economic policy to achieve a sustainable future, through a dynamic process that promotes public engagement and that aims to reach a much broader audience.

Lastly, reference is needed to the international System of Environmental-Economic Accounting (SEEA). This is a statistical framework for organising data, tracking changes in the extent and the condition of ecosystems, measuring ecosystem services and linking this information to economic and other human activity. The SEEA EA (SEEA Ecosystem Accounting), adopted by the UN Statistical Commission in March 2021, provides conceptual guidance for developing ecosystem extent, ecosystem condition and ecosystem services accounts. It presents a perspective where ecosystems and the services they provide interact as part of a natural process within a specific spatial area. A specific accounting format for ecosystems and their services in the European Union (EEA, Eurostat, 2021) has also been released.

2.3 The Conceptualization of ESS in Rural-Urban Synergies

Multiple interactive discussions with practice and research project partners in the six Living Labs (LL) inspired the findings in the CoP on ESS throughout the ROBUST project. Whether aiming towards provisioning, regulating, cultural or even supporting or habitat services, the meaning and relevance of ESS was structured using multiple lenses based on the diversity of ROBUST cases. The pluri-, inter- and trans-disciplinary nature of ESS was reflected in the eight analytical lenses represented in Fig. 2.3 which guided research to explore the potential role of ESS in promoting rural-urban structural and functional synergies. These eight lenses were identified by different partners, based on how they saw ESS playing a role in each LL in strengthening rural-urban synergies. The paragraphs below aim to summarise the scope of each of the eight analytical lenses that were further developed in the six LL through shared experiences and knowledge within this CoP.

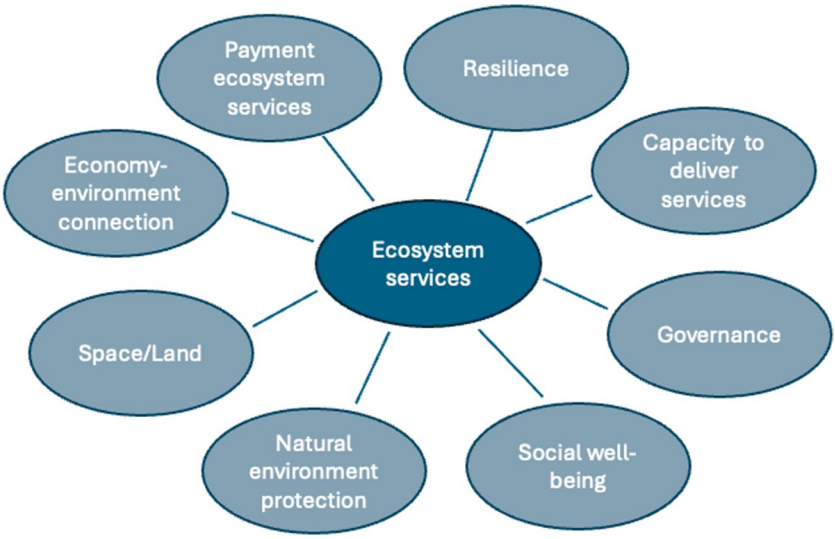

Fig. 2.3 Analytical lenses initially adopted in ROBUST to examine ESS

Capacity to offer ecosystem services: renewable energy, flood alleviation and risk management, recreational uses, carbon sequestration, waste, purification of air and water and climate change mitigation and adaptation; rural and environmental amenities; new environmental, cultural and recreational services; sustainable natural resource management, among others.

Payment for ecosystem services: remuneration for ecosystem services, the monetary compensation for stewards of ESS, as land managers, or users to maintain and promote ecosystem services.

Economy-environment connect: business opportunities; rural and urban social welfare; urban and rural green infrastructure complementarity: services from agriculture and forestry.

Social well-being: positive externalities or amenities enabled to individuals and groups, creating social capital and social cohesion rather than social exclusion.

Space/land: relates to scarcity of open space, conflicting demands for open space, i.e. often as land competition (housing with infrastructure development with natural environment protection).

Natural environment protection (biodiversity, water, distinctive landscapes)—conserving and protecting natural assets or resources (capital).

Resilience as the amount of change a system can undergo and still keep the same functions and structure, the degree to which a system is capable of self-organising; or the ability to build and increase the capacity for learning and adaptation.

Governance: rural-urban functions and local authority hierarchy; instruments and processes, related actors/players, governance arrangements; rural-urban multi-actor/player networks.

A first conceptualization of the role of ESS in rural-urban synergies is shown in Fig. 2.4. It identifies priority themes in the ROBUST cases, drawing from initial questions and challenges as CoP ESS work unfolded and materialised in the different LL contexts. This preliminary conceptual model intended to underline the need to: (a) ensure the balance between ESS supply (delivery) and demand (users); (b) seek the necessary instruments to enable such balance, including public policy, market and science and technology; (c) identify governance models to encourage alternative practices and policy-integrated goals, thus enabling resilience and social-well-being to occur. This was an early elaboration of the final conceptual framework (shown later in Fig. 2.6). Figure 2.4 maps the different dimensions that can be connected to reveal the understanding expressed in the multi-loop conceptual framework in Fig. 2.6. In short, Fig. 2.4 anticipates the role of ESS in rural-urban synergies, highlighting the importance of balancing ESS supply and demand, identifying necessary instruments and governance models, and promoting resilience and social well-being.

This initial conceptual model was then adapted to fit the ROBUST framework in which three main components play a key role in functional rural-urban linkages and synergies: new localities, smart development and network governance (Woods &

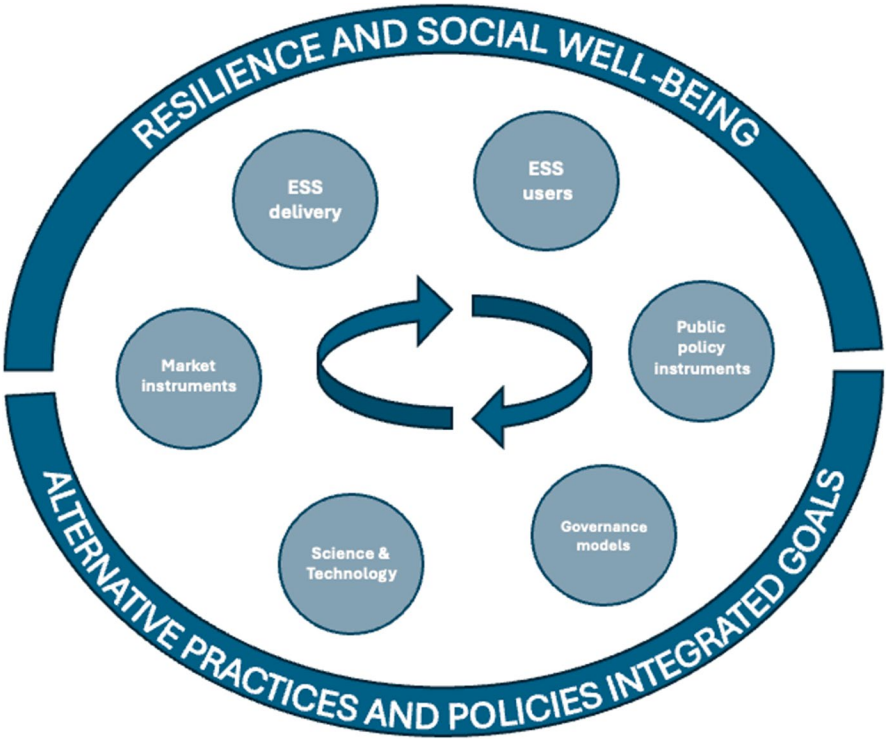

Fig. 2.4 Initial Conceptual model on the role of ESS in rural-urban synergies

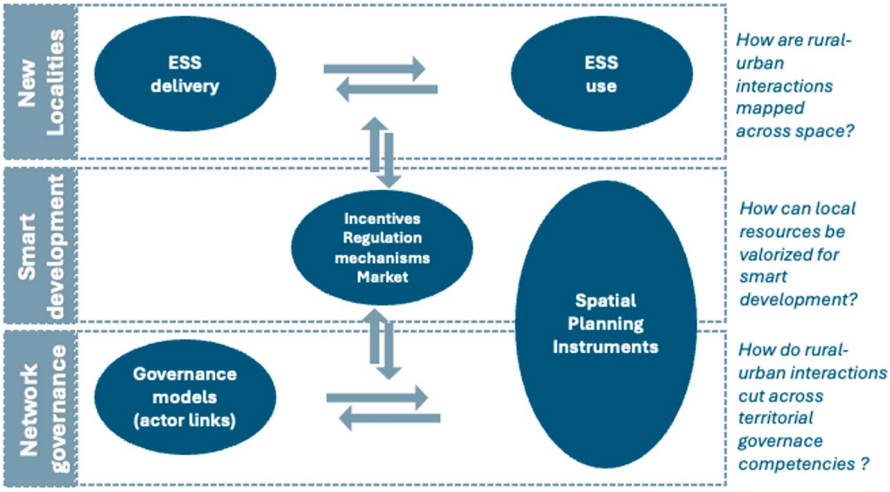

Fig. 2.5 Making ESS fit ROBUST rural-urban functional framework

Heley, 2017). Figure 2.5 represents the relationship that was established between the working concept adopted in CoP of ESS and the ROBUST framework.

ESS contribution to functional rural-urban relations was identified in CoP ESS in the following ways:

New localities ESS driven development can generate new localities engaging socio-ecological systems, relational space and flows and transactions associated with the creation of new values, perceptions and identities. Consequently, ESS driven development highlights proximate and distal rural-urban relationships, descriptions of which can be achieved through:

- Understanding the spatial planning system with a focus on its Outer Space[1] exploring how urban and rural features co-exist, overlap and compete;
- Including functional relations between urban and rural areas in the agendas of rural networks operating in the territory;
- Creating a "relational space" where it is possible to emphasise the multifunctional potential of rural, peri-urban and intra-urban areas;
- Mapping of ecosystem services based on spatial analysis (GIS) making explicit the locus of ESS delivery and use across space.

Smart development ESS highlights policy, market, sciences and technology tools to enhance socio-ecological systems, and exposes how rural-urban connectedness contributes to economic growth building, embedded in the resources of each spatial sphere. This may be achieved through:

- Reviewing policy processes;

[1] For the concepts of Outer Space and Inner Space please see Sect. 4.1.

- Providing actors/players with the (statistical and GIS) information needed to make more informed plans and decisions, and commit actors/players to this cooperation;
- Discussing the payment for ESS in the context of smart specialisation.

Network governance ESS builds upon collaborative arrangements with a cognitive reconfiguration of the territory to match ecosystem boundaries. This may be achieved through:

- Working on rural-urban synergy-building at a lower administrative level and by novel types of public-private partnerships, including cross-sectoral links (i.e. market, state, civil society);
- Expanding participatory and integrative municipal spatial planning procedures;
- Fostering community partnerships for ecosystem services provision;
- Putting in place arenas for bottom-up approaches to ESS mapping;
- Co-creating a new experimentalist rural-urban governance space.

2.4 The ESS Multi-Loop Framework

The ESS conceptual framework finally adopted is expressed through a multiple loop approach represented in Fig. 2.6. This ESS Multi-Loop framework was adapted to fit the ROBUST project, but it can also be used in other planning and policy contexts. In essence, ESS expresses a dialogue between users and services delivered within rural-urban contexts. But ESS is closely dependent on the resilience of the respective socio-ecological systems (SES) and its social well-being objectives. In a second loop, ESS users can influence the socio-ecological systems and its objectives, and consequently ESS outcomes through the application of appropriate tools including multiscale spatial policy and planning, market instruments, governance networks and science and technological tools. Placing it into a wider context in the third loop, desired socio-ecological systems are also dependent on societal values promoted by users, directly or indirectly, through the adoption of innovative multiscale spatial practices and policies that can enhance rural-urban synergies.

This framework was developed with the purpose of exploring rural-urban linkages and synergies in each LL, but it can also be replicated in other contexts. Research questions were established to guide and help materialise this framework (Table 2.1), which were used by different LL partners in exploring the ESS concept in their case studies.

The ESS research agenda priorities relevant for rural-urban synergies were then identified within the CoP and are represented in Table 2.2.

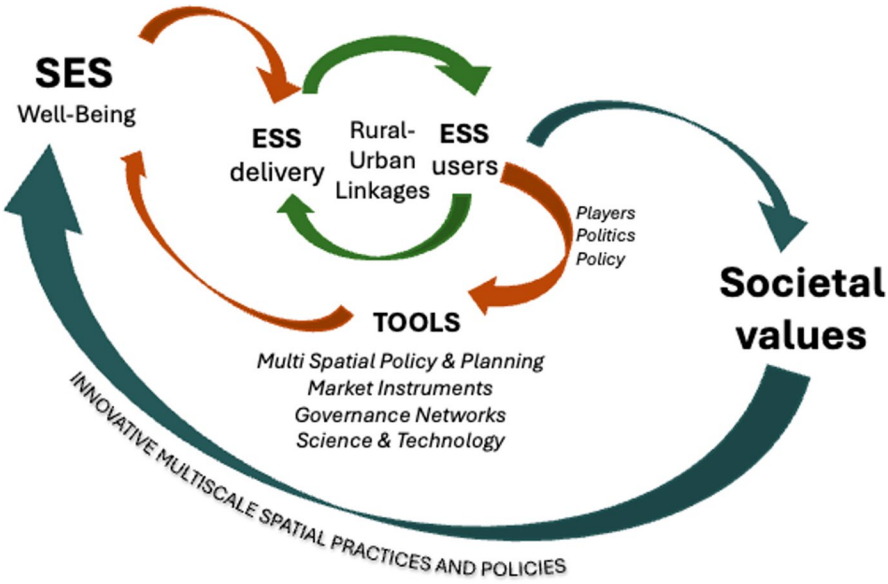

Fig. 2.6 ESS Multi-Loop framework in ROBUST

2.5 ESS and the Relevant Functions Leading Rural-Urban Synergies

Five core themes were adopted to explore the relevant functions whereby ESS could lead to rural-urban synergies. These were:

1. Circular Farming engaging ESS in rural urban synergies
2. Community Partnerships engaging ESS in rural urban synergies
3. Mapping ESS supply and demand for rural urban synergies
4. Multi-scale planning for ESS in rural urban synergies
5. Payment and compensation schemes for ESS in rural urban synergies

These five themes reflected the way research and practice partners in the CoP ESS translated the ESS conceptual model in Fig. 2.6 into their place-based applications. These show different emphases: on ESS delivery and user relationships (circular farming), on the well-being benefitting from rural-urban synergies, on ESS delivery and user relationships (community partnerships), on tools and innovative spatial planning and practices (mapping ESS, multi-scale planning and payment and compensation).

Figure 2.7 recognizes the inter-relationship of the five core themes of ESS that were investigated in the CoP ESS. It shows in particular how multi-scale planning enables the setting and integration of a policy framework; and how—by drawing on land value, devising payment and compensation schemes, and carrying out ESS

Table 2.1 Research questions to guide the application of the ESS Multi-Loop framework

ESS users:
Who are the actors or key players using ESS to enable rural-urban linkages/synergies?
Who benefits from ESS (directly or indirectly) in case of rural-urban linkages/synergies?
What are their roles? (e.g. responsibilities in government, producers, inhabitants, students/researchers)
How can ESS maps be used and interpreted? (e.g. matrix approach; monetary valuation; participatory GIS; social-cultural value)
ESS delivery:
Which ecosystems deliver which ESS that play a role in strengthening rural-urban linkages/synergies?
What is the land occupation associated with the ESS identified?
What are the conditions/quality of the ESS identified?
SES:
What are the main relationships, and dependencies, between social and ecological systems relevant in rural-urban linkages/synergies?
What conditions may stimulate, or threaten, such a balanced SES?
Tools:
What kinds of tools may enable the enhancement of SES in terms of its resilience and contributions to social well-being in the case of rural-urban linkages/synergies?
Benefits and Values:
What are the main benefits and core societal values that enable rural-urban linkages/synergies?

Table 2.2 ESS research and innovation agenda (RIA) priorities

1. How might ESS reinforce rural-urban relations?
2. How can multiple ESS be prioritised or balanced in a particular region, which are key, are they equally important?
3. How do different communities use ESS—what ESS indicators can be identified?
4. What governance models, and planning models, better practices (public and private), enable the delivery and responsible use of ESS?
5. What participatory measures help to raise awareness and engage people with ESS (gardening, birdwatching, among others)?
6. How do we discuss the unknowns of ESS (account for uncertainty) as a result of climate change, population dynamics, land use changes over time, among others?

mapping—ESS can be integrated in land use planning and also become a factor to be considered in land-take decisions. Synergistic business models can enhance the valuation of land based on ESS; this is foreseen for example in plans to harness ecological assets as commercial opportunities while recreating social and ecological capital cf. Chaps. 11 and 12. Similarly, community partnership represents a possible governance model to ensure that multiple stakeholders' values and priorities are engaged. Together synergistic business models and community partnerships (Chap. 5) facilitate networked governance approaches to decision-making, valuation and management of ESS. This can be exemplified with the value of ESS in

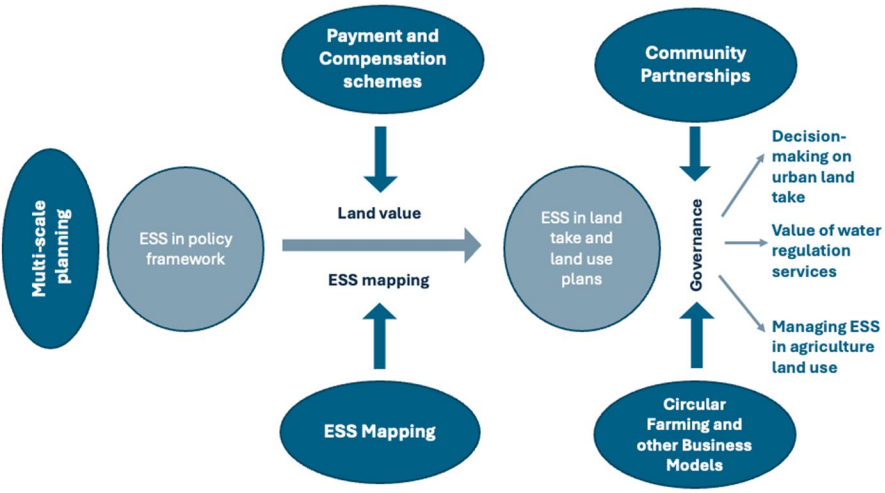

Fig. 2.7 Mapping the ESS core themes relative contributions to the rural-urban synergies research

water regulation, where these values are spatialized, and how subsequently the management of ESS in agriculture land use can be enabled through circular farming and community partnerships.

2.6 Relevance of Considering ESS in Spatial and Sectoral Planning at Different Geographical Scales—Implications for Multi-Level Governance

The research developed in ROBUST reiterates the importance of ESS as laid out in the literature and attempts to demonstrate, through the experiencing phase in ROBUST LL, that ESS can be crucial in ensuring and sharing the benefits across different types of territories (see for example in Chaps 5, 6, 8, 9 and 10). We aim in particular to emphasise that ESS serve to highlight the socio-ecological interdependence of rural and urban territories.

Improving interdependence requires better cross-sectoral (e.g. planning, economic development and resource management) policy co-ordination within territories. ESS need to be fully integrated at different scales of spatial planning—local, municipal and regional—in order to capture the cross-border reach of ESS (e.g. river catchments, landscapes, and shared public benefit). The ROBUST Living Lab approach shows potential in creating a common knowledge-base and lexicon on ESS amongst stakeholders across scales and sectors.

As suggested, since the earliest inception of the concept, ESS have been argued to provide substantial economic benefits, albeit not necessarily equally to all people.

There is still a major science-policy-practice gap that needs to be bridged to foster territorial applications. Incentives are needed in the market and public sectors to enhance green enterprise innovation in order to amplify this recognition, and consequently the enhancement of ecosystems that provide for those benefits. New forms of governance are needed that successfully involve and engage multiple urban and rural actors interactions and stimulate collective action. Contrasting to the market dimension brought up by green enterprises, spatial justice must be ensured in the inclusive access to ESS by valuing its public realm and equitable distribution of benefits (see Chaps. 9 and 14).

In essence, and drawing on the outcomes of the research developed in the CoP ESS in ROBUST, particularly in relation to the five core themes that were adopted, CoP findings can be synthesised in the following four respects.

Firstly, we recognize that rural-urban relations are fuzzy, however ESS can play a key role in constant rural-urban flows. It is helpful, therefore, to think of circular approaches in a territory in continuity. Rural-urban should be seen as a proxy for the dualism guiding land-take decisions in spatial planning, as they relate to developed land and not-yet-developed land, regardless of the areas in question being defined as rural or peri-urban.

Secondly, there is still a tendency to see rural areas as the exclusive ESS suppliers, and urban places as the exclusive ESS consumer, assuming that there is a unidirectional flow and thereby limiting the valuation of proximity services. Chapter 7 offers a practitioner's perspective on this assumption. More research and financial tools are needed to understand the optimal composition of blended (state-private) payment for ESS, for bundled ESS delivery. A vital aspect of this includes ensuring that longer-term ESS management is secured within spatial development.

Thirdly, ESS are not yet established in formal spatial planning procedures but are a crucial argument to inform decisions about land-take. The bundling of ESS will help to avoid duplication in assessment, as will the long-term monitoring of the impacts of different types of land management. Chapter 3 provides further arguments to support this and discusses the challenges in mapping and bundling ESS. To be noted however the notion of proximity if ESS delivery, as often relevant ESS (e.g. climate change regulations) can result from ESS that are not closely spatialized.

Fourthly, ESS mapping at multiple scales makes visible that ESS values are not absolute but are relative to the scale of analysis, the existing knowledge and the level of governance, thereby challenging cross-border mapping and scalar integration. There is a need for governance systems to strengthen rural-urban linkages, notably it is important to recognize the interconnection between urban and rural land managers. Rural land managers must be represented in spatial planning decision-making bodies, or consulted at the very outset of any intended interventions which demand land use change.

2.7 Conclusions

To conclude, our core learning points recognize that methodological development for ESS mapping needs to integrate multiple knowledge bases, including expert as well as traditional knowledge, while supply and demand need to be made explicit using a multiscale and multi-actor approach (as presented in Chap. 8). Further exploration of the scale-specificity of each ESS is also needed, as well as of ESS flows and the value of proximity. When bundling ESS, it is important to avoid double-counting while strengthening synergies and negotiating trade-offs. Finally, the integration of ESS in, or the connection to, multi-functional land use demands further research.

Clearly, governance arrangements are required to make decisions on ESS priorities and conflicts. There is a key role for community partnerships in setting new governance arrangements to enhance and promote ESS, as well as in taking care and preserving ESS needs. Novel governance arrangements are also needed for payments for ESS (PES), to ensure they are conducted in balanced ways to realise synergistic effects in equitable ways, while the potential of rural-urban contracts of reciprocity to enhance ESS should be further explored.

Green infrastructure (GI) needs to be valued as a tool to make ESS operational in rural-urban relations, to structure ESS flows and to contribute to practical implementation. To support this, maintenance and monitoring of interventions will be needed in the form of: (i) cross-sectoral monitoring partnerships at the initiation stage; (ii) blended and co-produced PES schemes which respond to local commercial interests and subsidies; (iii) recognition of the public realm of ESS as grounds for GI objectives and principles; and (iv) stronger and clearer regulation of long-term GI maintenance within development agreements.

Lastly, we found that the importance of spatial planning, especially in regulating urbanisation and categorising rural functions in our constituent LLs, highlighted mainly proximate rural-urban ESS relationships, such as water quality, waste cycles and landscape recreation. Other ESS, e.g. air quality, biodiversity (and its multi-level governance), and food production linked to global markets, exposed different constellations of stakeholders, governance arrangements and regulatory tools in dispersed rural-urban ESS relationships. In both cases, we were able to highlight the interdependence of rural and urban territories through ESS user-supplier relationships, also important when considering the contribution of ESS service delivery to regional economic growth.

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